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Differential impact of monsoon and late monsoon season on embryonic development of Amur Carp (*Cyprinus carpio haematopterus*)

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Abstract

The embryonic development of Amur carp (*Cyprinus carpio haematopterus*) throughout the monsoon and post-monsoon seasons is compared in this research work. During the regular and late breeding seasons, the study identifies the most critical features of the monsoon season that affect Amur carp embryonic development. The effects of temperature changes on embryonic development were evaluated by observing the morphological characteristics of the embryos and identifying the embryonic stages that eventually determined the impacts of temperature changes on embryonic development. According to present study, the development stages of eggs in the regular season are shorter than in the late monsoon season. Initially, eggs grow at the same time, but late monsoon eggs require more time to develop.

Keywords embryonic development, late monsoon season, monsoon

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Introduction

The Amur carp is a Hungarian-originated strain of wild common carp. Due to its superior growth performance over the previous strain, the Amur carp has a greater practical value in low-input aquaculture systems [1]. Amur carp has attained good somatic growth compared to common carp in different culture systems. Amur carp yielded 42% higher than local common carp [2]. The benthivorous fish can boost nutrient flux, which has a big impact on the abiotic and biotic aspects of the water column above. Aquaculture requires a thorough understanding of the evolution of fish. For successful artificial reproduction and fish seed production, observations on embryonic and early larval development are required. The goal of this study was to look at Amur carp embryonic development, under artificial propagation technique.

The early stages of teleost fish development, from fertilization to embryogenesis, often follow the same pattern. Despite scientific descriptions of eggs, embryo development, larval rearing methods, and advancements in larval output, improvements in larval production are still rare. Hatching and embryonic development occur at different times depending on the species and its surroundings. When the embryo has no egg membranes, it enters the free embryonic phase. When the larvae are capable of capturing the feed object, the larval stage begins. The key ecological aspect influencing the eggs growth is temperature. Some physical traits, hatchability, and larval behavior are all determined by it. Temperature requirements vary from species to species and even for

different developmental stages of a given species. Furthermore, the efficiency of egg yolk utilization is affected by temperature. The growth rate was reported to increase with increasing water temperature.

The major goal of the present work was to observe differences in the development of egg during diverse seasons and perceive the sway of water temperature on the hatching of eggs and developmental stages in Amur carp. This study may greatly support aquaculture/ fish farmers to successfully culture Amur carp during and after monsoons.

Methodology

Amur carp were received from the National Freshwater Fish Brood Bank, NFDB, Bhubneshwar, Odisha to the College of Fisheries, Dholi, Muzaffarpur for further study. Secondary sexual features were used to select fully mature females (average weight: 2.0 kg) and males (average weight: 1.5 kg).

Male and female broodstock of good quality and maturity were serene and moved to breeding tanks. Males and females were peritoneally injected ovafish [3]. Male along with female brood stock were released into aerated water in a circulating tank with water hyacinth after giving injection. Fertilization occurs shortly after the release of eggs and sperm. Cleavage begins at 39 minutes after conception. Hatching happens after 15 hours (monsoon season) and 18 hours (late-monsoon season) of breeding in circular spawning tanks with a diameter of 2m (late monsoon). The development of newly hatched larvae under a light microscope were observed.

Results and Discussion

The temperature and dissolved oxygen have been shown in Table 1. The environmental temperature was recorded around 28.350C to 30.450C and water temperature was nearly 26.300C to 28.230C. DO value were ranged 4-6 mg/L without any significant variation between seasons.

Embryonic development was monitored from 0 to 78 hours, showing in Figure 1 (A) showing embryonic development in the Monsoon season, and Figure 1-9 (B) depicts embryonic development in the late Monsoon season. Blastodisc formation began in 4 hours (MS) and 6 hours (LMS). Between 6 and 8 hours (MS), blastomeres begin to aggregate and the morula stage begins to differentiate (LMS). In 11 hours, the embryo began to develop. The developing embryo's head region differentiates in 9 hours (MS) and 10 hours (LMS). In 12 hrs [MS-Fig 4(A)] & 14 hrs [LMS-Fig 4(B)], brain and body parts were visible.

Table 1. Parameters of water quality observed in breeding seasons

Parameter	Dissolved oxygen (mg/L)	Temperature (°C)	
		Environmental temperature	Water temperature
Normal monsoon season	4-6	28.35	26.30
Late monsoon season	4-6	30.45	28.23

Well-differentiated brain regions were observed in 18 hrs (MS) & 20 hrs (LMS), after that, demarcation of the eye and respiratory parts in 24 hrs (MS) and 26 hrs (LMS). The digestive structure was fully functional within 48 hrs [MS-Fig 7(A)] and 50 hours [LMS- Fig 7(B)], while insertion of the yolk sac, expansion of fins, and pigment cells were identified in 78 hrs [MS- Fig 9(A)] and 86 hrs [LMS- Fig 9(B)]. Fertilized eggs were sticky, demersal, and adhesive. The standard thickness of the egg was 0.8 mm. There was a cap-like structure that slowly expanded in size over the animal pole. The complete incursion of yolk by progressive distribution over the germ layer identifies by the yolk plug. The tail and head of the embryo were obvious & distinct at this time. The embryo ringed the yolk material and was elongated. Both the tail and the head ends were distinct. The twisting movements became more forceful over time, and the egg capsules weakened and broke.

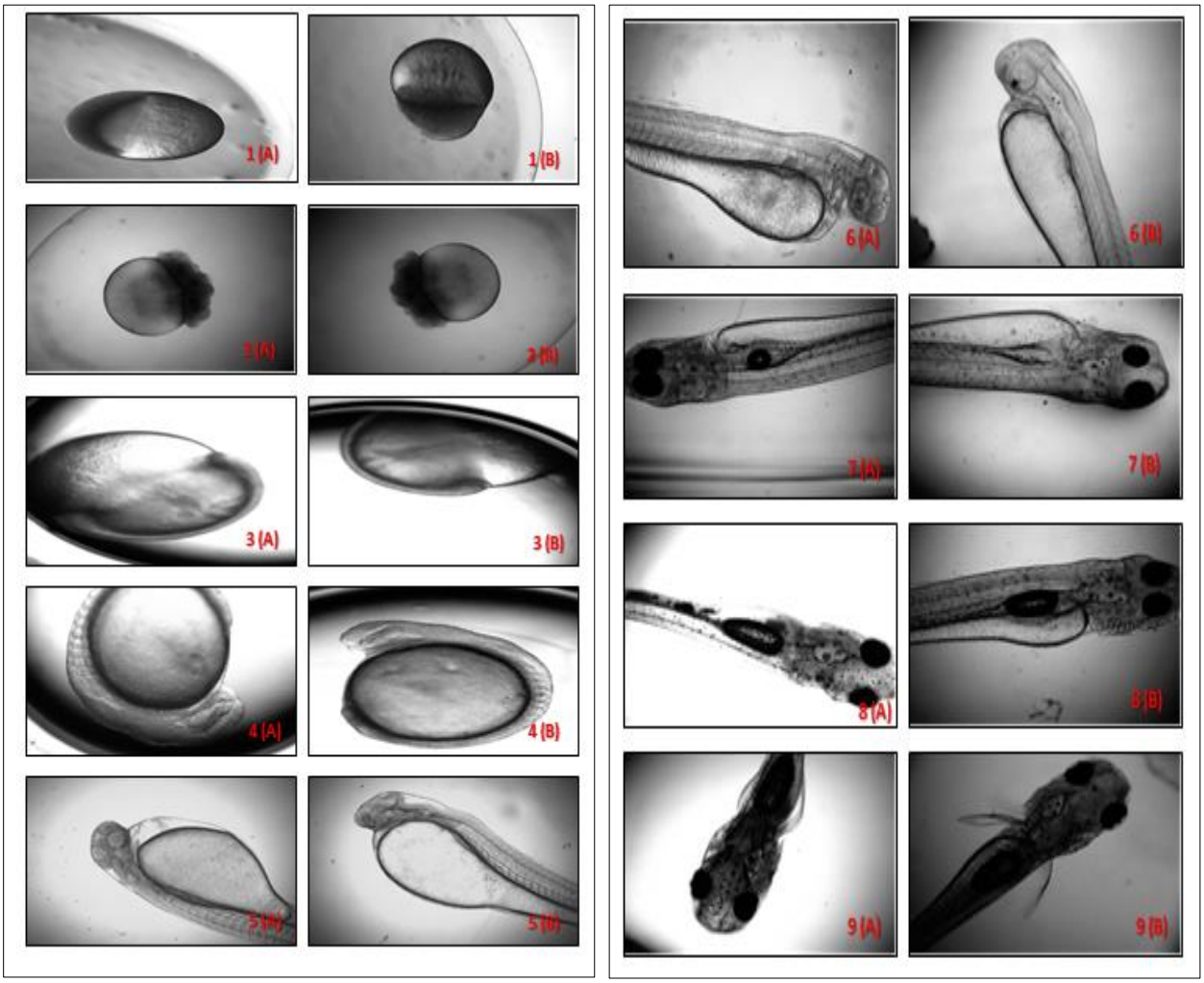

Figure 1. Embryonic development in Amur Carp during monsoon [MS (Fig.1-9 (A)] and late monsoon season [LMS (Fig. 1-9(B)]

1 (A) (MS-4Hr): Blasto-disc development, 1 (B) (LMS-6Hr): Blasto-disc development,
2 (A) (MS -6Hr): Differentiation of morula stage, 2 (B) (LMS-8Hr): Differentiation of morula stage,
3 (A) (MS-9Hr): Developing embryo with head region, 3 (B) (LMS-10Hr): Developing embryo with head region,
4 (A) (MS-12Hr): Embryo with body somites and brain vesicles, 4 (B) (LMS-14Hr): Embryo with body somites and brain vesicles,
5 (A) (MS-18Hr): Differentiated brain parts, 5 (B) (LMS-20Hr): Differentiated brain parts,
6 (A) (MS-24Hr): Eye ball and well differentiated branchial and vascular bed of vessels, 6 (B) (LMS-26Hr): Eye ball and well differentiated branchial and vascular bed of vessels,
7 (A) (MS-48Hr): Hatchling showing well developed and functional digestive system, 7 (B) (LMS-50Hr): Hatchling showing digestive system,
8 (A) (MS-68Hr): Hatchling showing actively functional digestive system, 8 (B) (LMS-74Hr): Hatchling showing functional digestive system,
9 (A) (MS-78Hr): Hatchling showing complete yolk sac absorption, 9 (B) (LMS-86Hr): Hatchling showing presence of rudimentary yolk sac

The embryo's persistent lashing action shattered the egg shell. In MS, hatching took occurred at 27°C, while in LMS; it took place at 29°C. Larval hatching occurs 3 days after fertilization for common carp and 32 hours for silver carp at water temperature 22-23oC, transition to exogenous feeding 7 days for common carp and 5 days after fertilization for silver carp [4]. After hatching, the size of the spawn measured 2.0 mm. Larvae were slight, straight, and apparent. The embryonic development takes about 78 hours during monsoon season [Fig 9 (A)] and about 86 hours [Figure 9(B)] during late monsoon season. The difference in time between the two seasons is around eight hours. So, we can say that Amur carp development is superior and more proficient in monsoon season compared to another season because gonads are full of excellent quality eggs with superior

development ability during the monsoon season, whereas gonads are filled with more spent stages with poorer quality eggs and deprived growth potential during the late monsoon season. In this research work, we succeeded to obtain the spawn of Amur Carp in MS and LMS, although embryonic development was slowed in LMS and yolk absorption was slow. Organogenesis was also delayed as a result of delayed yolk absorption. The fertilized eggs were round and orangish-yellow in color. Researchers discovered similar results in *L. rohita* study [5]. After fertilization, the diameter of rohu eggs ranges from 4.1 to 4.8 mm [6]. The variation in egg sizes was attributed to seasonal variations and the size of the brooder. Even within a species, the size of the enlarged fertilized eggs can vary greatly.

During 24-68 hours (Fig 6-8), the eyeball, branchial and vascular bed of vessels, and an actively operating digestive system with fibrous waste particles were observed in experimental fish. The research was comparable to that done on *C. mrigala* and *Catla catla* [7].

The rigidity of late breeding rohu in terms of product and quality of eggs, embryonic development, and hatchlings was lower when compared to the response variables in monsoon bred fish. Delayed-induced spawning in carps frequently results in poor spawning performance and a decrease in the value of the final product [8]. This variation in the maturational state affects the pace of ultimate oocyte maturation in *L. rohita* and, as a result, culpability for declines in egg output and quality. When silver carp oocytes were treated in-vitro orientation for last oocyte maturation during the post-spawning period, a similar observation was made [9].

The embryonic and larval development of Amur carp was investigated at the water temperature of 26°C-28°C. Other species had different rates of larval development [10]. Temperature is assumed to have a role in this variance; the greater the temperature, the faster the development [11]. All ecological parameters influence early ontogeny, including oxygen, salinity, pH, temperature, precipitation, winds, and various biotic and human-related factors [12-14].

Conclusion

The current study uncovered some details about the early stages of development and larval growth of Amur carp. This research will aid fisheries biologists in better understanding the stages of the embryo, which will be useful in determining the best course of action for the long-term development of Amur carp culture and management technologies.

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